Agreement between interview data and a self-administered questionnaire on dietary supplement use

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Agreement between interview data and a self-administered questionnaire on dietary supplement use

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Objective: To study the relative validity of an open-ended question on the consumption of dietary supplements in the preceding five-year period, incorporated in a self-administered questionnaire used in the NLCS, The Netherlands Cohort Study on diet and cancer (120 852 men and women aged 55–69 years).
Design: Questionnaire data were compared with reference information from three personal interviews carried out within a period of 10 months.
Setting and subjects: A randomly selected subgroup (59 men and 50 women) of the cohort living in 12 municipalities in the eastern and western regions of The Netherlands.
Results and conclusions: The overall sensitivity of the questionnaire concerning the use of any dietary supplement was 65.9%, the specificity was 98.5%; kappa as measure of agreement was estimated at 0.69. A high percentage recall was observed among women, users of at least three types of dietary supplements, long-term supplement users and those in the oldest age group. Recall of intake of specific supplements ranged from 77.8% for garlic preparations to 11.8% for 'other' supplements. Estimates of consumption of specific supplements (garlic and vitamin preparations) may provide enough precision to correctly classify individuals as users or non-users of those supplements.
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Descriptors: dietary supplements, epidemiological measurements, garlic preparations, interviews, questionnaires, vitamin supplements

Introduction

Dietary supplements, especially vitamin and mineral preparations, may be regarded as important sources of micronutrients. Therefore, studies of nutrient intakes should include the intake of dietary supplements (Willett *et al.*, 1981; Gray, Paganini-Hill & Ross, 1983; Block *et al.*, 1988; Subar & Block, 1990). Moreover, because of their widespread use and their proclaimed long-term health effects, it will be important to investigate the health consequences of dietary supplements specifically (Willett *et al.*, 1981; Subar & Block, 1990).

In epidemiological research on the role of diet in relation to disease, self-administered questionnaires are frequently being used to estimate an individual's long-term nutrient intake. To estimate the intake of micronutrients on a large scale a questionnaire is often the only feasible method (Block *et al.*, 1990). For accurate ranking of individuals into vitamin and mineral intake categories the inclusion of dietary supplements in the assessment of dietary

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intake is required, since much of the variation in total vitamin intakes may be due to variation in supplemental vitamin intakes (Gray *et al.*, 1984; Kune, Kune & Watson, 1987). Ideally, the ability of a questionnaire to measure what it intends to measure, i.e. its validity, should be established before the study is started, preferably in the population in which the relation between the exposure and the outcome will be studied (Block, 1982; Block & Hartman, 1989; Nelson, 1991). In some studies on the relation between diet and disease using questionnaire information of dietary intake of macro- and micronutrients, the intake of micronutrients has been validated also taking into account the consumption of micronutrients by dietary supplements (Gray *et al.*, 1984; Willett *et al.*, 1985; Block *et al.*, 1990). The validity of data concerning dietary supplement use itself, however, has received only limited attention (Gray *et al.*, 1984).

In 1986, the Netherlands Cohort Study (NLCS), a large-scale cohort study on the relation between diet, dietary supplement use, lifestyle factors and cancer, has been started among 120 852 persons aged 55–69 years (Van den Brandt *et al.*, 1990). The validity of the self-administered, semiquantitative food frequency questionnaire has been studied in a subgroup of the cohort by comparing the questionnaire with three 3-day diet records 4–5 months apart (Goldbohm *et al.*, in press). As part of this validation study the participants have also been interviewed by trained dieticians regarding the use of dietary supplements. The aim of the current report is to describe the relative validity of the questionnaire on the use of dietary supplements by comparing it with data collected by interview.

Methods

Subjects

Subjects were participants in a validation study of a semiquantitative food frequency questionnaire against the 9-day record. These persons (n = 212) were sampled from the cohort after the baseline measurement. The study population consisted of 109 participants (59 men, 50 women). Reasons for non-participation could be attributed to: unavailability (e.g. death, absence, n = 29) or refusal (n = 68) and inability to keep a good record (n = 6). A detailed description of the response and reasons for drop-out or exclusion has been made (Goldbohm *et al.*, in press).

Reference method

The reference method in the validation study consists of information collected by interview. Although dietary intake itself has been validated against the mean of three 3-day diet records, additional information on use of dietary supplements has been collected by interviewing participants at home by trained (student) dieticians in September 1987, January 1988 and July 1988. Participants were probed to report their current use of dietary supplements by asking: 'Do you use vitamins, minerals, garlic pills, lecithin or other health preparations?'. For each reported supplement, the following information was recorded: type of supplement (generic name), brand name, manufacturer or distributor, location of purchase, frequency of consumption, number of doses per consumption and the starting date. When available, information from product labels has been copied.

Questionnaire

On average 3 months after the third interview the participants were requested to complete a duplicate of the self-administered questionnaire used to measure baseline exposure in the entire cohort in 1986. The question on the use of dietary supplements included in this questionnaire is as follows: 'During the past five years did you use vitamin tablets, drops or other preparations (for example tonics, vitamins, garlic pills, brewers' yeast, calcium)?'. In the open-ended part of this question the participant could add the type of supplement, brand name and dose per day. For each of the maximal four supplements that could be listed, information on the first (starting) and last (stopping) years of intake had to be provided. Vitamin AD supplement was given as example.

Coding and key-entering of reference and questionnaire data

Because both the reference and questionnaire data on the use of specific dietary supplements were derived from an open-ended question, we had to develop a definition of a dietary supplement in order to exclude information on other preparations, such as drugs or cosmetics. A preparation was defined as dietary supple-

ment based on the following criteria: tablets, capsules, oral solutions, syrups, powders or wafers containing substances that can be consumed as part of a normal diet. Besides vitamins, minerals or preparations derived from complete foods such as garlic, supplements like spirulina, which contains B complex vitamins, or wheat germ oil, an important contributor of vitamin E, were included. Preparations that cannot be taken orally (e.g. injectable solutions, or shampoos and cosmetics containing vitamins) were excluded, as well as preparations that have been 'potentiated' (homeopathic drugs), medicinal herbs and drugs. All information on dietary supplements collected by interview has been coded in as detailed a way as possible. For this reason we used a comprehensive list of dietary supplements available in The Netherlands, which we constructed based on detailed information provided by manufacturers and distributors. Questionnaire data have been double-keyed and checked by research assistants using the same list of dietary supplements. When details on the brand name or manufacturer were not available, the preparation was coded according to its generic (type) name. Since we only have reference data of dietary supplements consumed at the time of the interviews, information from the questionnaire has been excluded if the preparation had not been used in the period covered by the interviews.

Data analysis

Concerning the interview data, individuals reporting the use of any dietary supplement in at least one of the three interviews were considered as dietary supplement users. An individual was classified as a 'true positive' overall user of dietary supplements when at least one specific type of dietary supplement was recorded in the questionnaire and in at least one interview. 'True negatives' were individuals who did not consume supplements according to both the interview and the questionnaire.

Regarding overall use of dietary supplements, a two-by-two table was used to calculate the sensitivity (i.e. the probability that a user of dietary supplements as defined by interview will be correctly classified based on questionnaire information), specificity (i.e. the probability that a person not using supplements as defined by interview will be classified as non-user based on questionnaire information) and the predictive value of a positive or negative response to the open-ended question included in the questionnaire. To account for the contribution of chance agreement between the interview method and the questionnaire, we also calculated kappa values (Landis & Koch, 1977).

Since only one supplement user recorded the consumption of dietary supplements in the questionnaire while in the interviews this person did not mention the use of any dietary supplement (i.e. a 'non-user'), we further concentrated on sensitivity of overall supplement use when analysing the effect of factors that might have influenced the use of dietary supplements or the ability to recall their consumption.

Besides personal characteristics (age and sex), we studied the influence of the number of different supplements used and the total number of doses per day on recall of dietary supplement use. To evaluate the influence of duration of supplement use on the sensitivity of the questionnaire, we categorized subjects into short-term (1 year) and long-term (≥2 years) users according to the total duration of dietary supplement use as assessed in the interviews. For each subject the total duration of use was calculated by subtracting the earliest year in which the subject had started with the consumption of supplements from the year in which the current use had been reported. Participants were categorized in the '1 year' category when the consumption of all supplements was started in the year preceding the interviews (1987–1988). When at least one supplement had been used for 2 years or more or when only 'years' was mentioned, the user was categorized in the '≥2 years' category. When one of the data on starting or stopping year in the questionnaire was missing, the total duration was set to 1 year. Finally, for each specific supplement type the percentage recall obtained by questionnaire was measured by assessing the degree to which the consumption of these supplements was recalled by the participants.

Results

Table 1 presents a description of the study population. Of the 109 participants included in the analysis, 41 were users of dietary supple-

Table 1. Characterization of persons participating in a study on the validity of a self-administered questionnaire, interviewed at home on the use of dietary supplements

Characteristic	*Total*	*Dietary supplement users*			
		Interview		*Questionnaire*	
		n	*%*	*n*	*%*
Total	109	41	37.6	28	25.7
Sex					
Men	59	19	32.2	9	15.6
Women	50	22	44.0	19	38.0
Age (years)					
55–59	43	18	41.9	13	30.2
60–64	42	14	33.3	7	16.7
65–69	23	9	37.5	8	33.3

ments according to the interviews. The proportion of dietary supplement users was higher among women than among men (44.0% and 32.2% respectively). The highest proportion of users was found in the youngest age category (55–59 years): 41.9%. Among women the proportion of supplement users within each age category was higher than among men. The proportion of dietary supplement users according to the questionnaire was lower than the proportion found by interviewing the subjects (25.7%). The highest proportion of users was also observed among women (38.0% versus 15.6% in men), while in contrast with data from the interviews, a higher proportion was found among persons in the oldest age category (33.3%) than in the youngest age category (30.2%).

Table 2 shows a two-by-two table comparing the information on overall use of dietary supplements collected by the questionnaire with those from the interviews. Twenty-seven of the 41 individuals using dietary supplements according to the interviews mentioned at least one type of supplement in the questionnaire that also had been reported in one of the interviews. Thus, the sensitivity was 65.9%. Only one of the 68 non-users according to the interviews reported the consumption of a dietary supplement in the questionnaire, resulting in a specificity of 98.5%. The predictive value of a positive response was higher than that of a negative response (96.4% vs 82.7%). The value of kappa was 0.69.

Table 2. Use of dietary supplements according to questionnaire information and information from three personal interviews

		Interview		
		User	*Non-user*	*Total*
Questionnaire	*User*	27	1	28
	Non-user	14	67	81
	Total	41	68	109

Because of the high specificity of the questionnaire concerning the overall use of dietary supplements, the influence of various factors is only reported for the sensitivity (Table 3). The percentage recall of overall dietary supplement use in the questionnaire was higher among women than among men (81.8% and 47.4% respectively). When the number of different types of supplements reported in the questionnaire rose from 1 to 3 or more, the sensitivity increased from 50.0% to 100%. Among subjects using only one type of supplement the sensitivity was also higher for women than for men (70% and 33.3% respectively). Table 3 also shows that the percentage recall of overall dietary supplement use was higher in the oldest age category than in the category 55–59 years (88.8% and 66.7% respectively) or among persons aged 60–64 years (50%). Six of the 14 '1 year' users (42.9%), and 21 of the 27 subjects in the '≥2 years' category (77.8%) recalled their consumption in the questionnaire. The total number of doses per day was not related to recall of dietary supplement use.

Table 3. Number and percentages with 95% confidence intervals (CI) of subjects using dietary supplements as reported by a self-administered questionnaire compared to information from three personal interviews, stratified by several characteristics

	Interview	*Recall in questionnaire*		
	n	*n*	*%*	*(95% CI)*
Overall	41	27	65.9	(49.4–79.9)
Sex				
Men	19	9	47.4	(24.4–71.1)
Women	22	18	81.8	(57.9–100)
Number of different types of supplements				
1	22	11	50.0	(28.2–71.8)
2	8	5	62.5	(24.5–91.5)
≥3	11	11	100	
Age (years)				
55–59	18	12	66.7	(41.0–86.7)
60–64	14	7	50.0	(23.0–77.0)
65–69	9	8	88.8	(51.8–100)
Total number of years of supplement use				
1	14	6	42.9	(17.7–71.1)
≥2	27	21	77.8	(57.7–91.3)
Total number of doses per day				
<3	22	15	68.2	(45.1–86.1)
≥3	19	12	63.2	(38.3–83.7)

In Table 4, the sensitivity of the questionnaire is presented for each type of supplement separately, in descending order of percentage recall. Although broad categories of supplements are presented, analysis of agreement per unique type of dietary supplement was conducted. Of the 86 supplements reported by interview, 46 were mentioned in the questionnaire (53.5%). The percentage recall of the use of garlic preparations was highest (77.8%). Recall of overall vitamin supplement use was 72.7%, although both vitamin E (n = 4) and vitamin AD (n = 3) were recalled by 100% of the users. Vitamin B consumption (including the B complex preparations, vitamin B_1, B_6 and B_{12}) was recalled by 72.7% and vitamin C and multivitamin/minerals both by 60% of the users. The most frequently consumed supplement according to the interviews, calcium (n = 15), was recorded in the questionnaire by eight

Table 4. Numbers and percentages with 95% confidence intervals (CI) of different types of dietary supplements as reported in a self-administered, mailed questionnaire compared to information from three interviews, ordered in decreasing percentage of agreement

	Interview	*Recall in questionnaire*		
Type	*n*	*n*	*%*	*(95% CI)*
Overall	86	46	53.5	(42.4–64.3)
Garlic	9	7	77.8	(40.0–97.2)
Vitamins[a]	33	24	72.7	(54.5–86.7)
Calcium	15	8	53.3	(26.6–78.7)
Lecithin	9	4	44.4	(13.7–78.9)
Brewer's yeast	3	1	33.3	(0.8–90.6)
Other[b]	17	2	11.8	(1.5–36.4)

[a] Vitamin A, AD, B_1, B_2, B_6, B_{12}, B complex, C, E, multivitamins.
[b] Iron, zinc, kelp, bee pollen, fibre, wheat germ oil, ginseng, combinations or other.

subjects (53.3%). The percentage agreement between questionnaire and reference interviews regarding other supplement types was considerably lower.

Discussion

In The Netherlands, dietary supplements are obtainable from pharmacies on prescription or as 'over the counter' products, and from drugstores, health food stores, supermarkets and mail order companies. Dietary supplements are generally used by individuals to supplement a potential deficiency in the diet and/or to benefit from their supposed health effects (English & Carl, 1981; Read & Graney, 1982; Kellett *et al.*, 1984; Worsley & Crawford, 1984; Turlings & Feenstra, 1987; Payette & Gray-Donald, 1991). Some preparations, such as vitamin B complex, iron, multivitamins, and calcium with vitamin D, are also being prescribed or recommended by health professionals to treat or prevent symptoms of deficiency (Groot & Hautvast, 1979; Sorensen, Sorensen & Zimmer, 1979; Schneider & Nordlund, 1983; Gray *et al.*, 1983; Council on Scientific Affairs, 1987; Sobal, Muncie & Koch, 1988).

In our cohort study, baseline information on the intake of dietary supplements has been collected in 1986 with a self-administered questionnaire. The relative validity of the questionnaire on the use of specific types of dietary supplements has been examined afterwards by using interviews held in 1987 and 1988 as reference method for comparison with data collected by readministering the questionnaire in 1988. Although the overall sensitivity of the questionnaire concerning the measurements of overall use of dietary supplements is moderate (65.9%), a high percentage recall was observed among women, users of at least three dietary supplements, long-term supplement users and in the oldest age group. According to the classification of kappa proposed by Landis & Koch (1977), our questionnaire is an instrument with 'substantial' validity in measuring overall use of dietary supplements (kappa = 0.69). The percentage recall of specific types of supplements varied considerably: from 77.8% for garlic supplements to 11.8% for supplements in the 'other' category.

Besides general problems of using interview data as reference (interview data can be subject to response error, and also might not reflect true intake (Block & Hartman, 1989; Block *et al.*, 1990; Van den Brandt *et al.*, 1991; Fogelholm & Lahti-Koski, 1991), the relative validity might have been affected by the sequence of administration of the interviews and the questionnaire. Since reference data were collected before completion of the questionnaire and within the predefined period of consumption, a better interpretation of the open-ended question in the questionnaire or, less likely, induction of a change in dietary supplement consumption might have occurred (Willett *et al.*, 1985; Nelson, 1991; Fogelholm & Lahti-Koski, 1991). Comparison of questionnaire data collected in 1988 with those collected at baseline in 1986 revealed that among the 18 long-term (i.e. ≥2 years) dietary supplement users in 1988 three persons had provided information on supplements which were already used but not reported in 1986. Among the other 15 long-term supplement users, five extra supplements, which should have been reported in 1986, were mentioned. These observations may be regarded as supportive for the suggested learning-effect due to the sequence of administration.

The low overall sensitivity of our questionnaire in measuring intake of specific supplements was mainly due to dietary supplements other than those probed for in the questionnaire. These supplements might not have been mentioned by the respondents because of misinterpretation of the nature of the requested information, the difficulty to distinguish dietary supplements from drugs, or the difference between examples of dietary supplements provided in the interviews and the questionnaire. Although these problems are less likely to occur with well-defined supplements like vitamins and garlic preparations, for which we found the highest percentages of recall, the low percentage recall of lecithin supplements might have been the result of this. The design of the open-ended question, with space for adding a maximum of four different supplements, might also have been accountable for a low percentage recall of intake of specific types of dietary supplements: four of the seven 'unrecorded' calcium supplements were consumed by subjects taking at least four other supplements. The low percentage recall of calcium supplement use might also have been caused by their use as 'therapeutics', since most of them were con-

sumed by the female participants, for whom calcium supplements might have been recommended by health professionals to prevent postmenopausal complications (Thompson & Tollison, 1990). The lower recall of vitamin C (60%) may be due to a seasonal variation in use reported for vitamins (Dorant *et al.*, 1991): some people take vitamin C in the winter only, whereas the questionnaire was completed in September.

The consumption of dietary supplements cannot be assumed to be stable over time. Apart from the already mentioned seasonal variation in use, proclaimed beneficial effects of dietary supplements, especially for elderly persons, might lead to variations in consumption. Furthermore, the availability of supplements on the market as well as the number of available supplement types might have changed. The validity of the questionnaire might have been affected by these circumstances and our results reported here relate therefore, strictly speaking, only to the time period in which the validation study took place. However, in the study by Gray *et al.* (1984), a close agreement (84%) between questionnaire information on overall use of vitamin supplements has been reported after comparing it with interview data collected 15 months later. Thus, for specific categories of dietary supplements the validity of the questionnaire might not be confined to a specific period. Comparison of our results with those reported in other studies on validity of dietary intake measurements is complicated because, in contrast with other studies, we have validated an open-ended question, and we developed a definition of a dietary supplement that includes preparations other than only vitamins and minerals (not including drugs). Also, this is the first study that specifically investigated the relative validity of a questionnaire on dietary supplement use. However, since dietary supplements closely resemble drugs (in form and pattern of use) and reasons for taking them are reported to be similar (English & Carl, 1981; Read & Graney, 1982; Levy & Schucker, 1987), the validity of the questionnaire estimating exposure to dietary supplements can also be compared to the validity of questionnaires measuring long-term drug use.

In medical research self-administered questionnaires are sometimes being used as the only source of information on exposure to medical treatments or interventions, such as exposure to drugs or radiation. However, the validity of exposure estimates, obtained from self-administered questionnaires, has still received limited attention. In a literature search by Harlow & Linet (1989) only two studies were identified concerning non-hormonal, non-pregnancy-related drugs. In one of these studies, by Paganini-Hill & Ross (1982), the proportion of agreement with respect to information on non-hormonal drug use between interviews, medical charts and pharmacy records ranged from 69% to 7%, with kappa values ranging from 0.24 to 0.62, depending on type of drug. Pecoraro *et al.* (1979) compared information on exposure to non-prescription drugs or tonics, such as 'diet pills' and vitamins, determined with a health history questionnaire, with those produced by the history provided in a traditional history interview. Recall of non-prescription drugs was 65% among 23 patients newly referred to a veterans' medical centre. In our cohort study, questionnaire information on drug use has been compared with pharmacy records of dispensed drugs. Overall, the results of this comparison agree reasonably well with those of the relative validity of the questionnaire with respect to dietary supplement use. Analogous to our observations on the recall of dietary supplement use, an increase in recall was seen with longer duration of long-term drug use. However, stratification of recall of current long-term drug use by gender, age, number of prescribed drugs and duration of use, revealed that gender and duration of use were not related to drug recall, while with increasing age or higher number of prescribed drugs recall slightly decreased (Van den Brandt *et al.*, 1991). In a study by De Jong *et al.* (1991) on the validity of a questionnaire on medical drug use in a selected group of women with high-risk pregnancies, the percentage recall of the intake of vitamin- and mineral-containing drugs during pregnancy was very low (31%) compared to our results (33%).

In epidemiological studies on the relation between nutrition and disease, the intake of dietary supplements should be measured in order to estimate the exposure of the study population to important nutrients. Gray *et al.* (1984) suggested that estimating total vitamin A and C intakes might best be accomplished by asking the amount of vitamin supplement intake and frequency of use of a few selected foods.

However, this is only correct when a considerable proportion of the study population consumes specific vitamin supplements, information on the vitamin content of each supplement is available, valid estimates of true intake by supplements can be calculated, and information on timing of consumption is available. Furthermore, if supplement use varies between demographic subgroups (Block *et al.*, 1988; Subar & Block, 1990; Block *et al.*, 1990), problems may arise in the estimation of nutrient intake proposed by Gray *et al.* In general, estimating the total consumption of vitamins by supplements is complicated because vitamins are not only consumed as single vitamin preparations but also as multivitamin/mineral preparations with varying amounts of vitamins (Park, Kim & Yetley, 1991), and other vitamin-containing supplements such as wheat germ oil and brewers' yeast (Dorant *et al.*, 1991). To evaluate separately the effect of dietary supplements on disease, valid estimates should be available on the use of these supplements.

In our prospective cohort study, estimates on intake of specific supplements (e.g. garlic preparations and vitamins) may provide enough precision to correctly classify individuals as user or non-user of those supplements.

References

Block G (1982): A review of validations of dietary assessment methods. *Am. J. Epidemiol.* **115**, 492–505.

Block G & Hartman AM (1989): Issues in reproducibility and validity of dietary studies. *Am. J. Clin. Nutr.* **50**, 1133–1138.

Block G, Cox CC, Madans J, Schreiber GB, Licitra L & Melia N (1988): Vitamin supplement use, by demographic characteristics. *Am. J. Epidemiol.* **127**, 297–309.

Block G, Woods M, Potosky A & Clifford C (1990): Validation of a self-administered diet history questionnaire using multiple diet records. *J. Clin. Epidemiol.* **43**, 1327–1335.

Council on Scientific Affairs (1987): Vitamin preparations as dietary supplements and as therapeutic agents. *J. Am. Med. Ass.* **257**, 1929–1936.

De Jong PCM, Huijsmans AA, Nienhuis HE, Nijdam WS, Zielhuis GA & Eskes TKAB (1991): Validation of a questionnaire on medical drug use during pregnancy. *Am. J. Epidemiol.* **134**, 998–1002.

Dorant E, Van den Brandt PA, Hamstra AM, Feenstra MH, Bausch-Goldbohm RA (1991): Gebruik van voedingssupplementen in Nederland. *Ned. Tijdschr. Geneeskd.* **135**, 68–73.

English EC & Carl JW (1981): Use of nutritional supplements by family practice patients. *J. Am. Med. Ass.* **246**, 2819–2721.

Fogelholm M & Lahti-Koski M (1991): The validity of a food use questionnaire in assessing the nutrient intake of physically active young men. *Eur. J. Clin. Nutr.* **45**, 267–272.

Goldbohm RA, Van den Brandt PA, Brants HAM, Van't Veer P & Al M (In press): Validation of a dietary questionnaire used in a large-scale prospective cohort study on diet and cancer. *Eur. J. Clin. Nutr.*

Gray GE, Paganini-Hill A & Ross RK (1983): Dietary intake and nutrient supplement use in a Southern California retirement community. *Am. J. Clin. Nutr.* **38**, 122–128.

Gray GE, Paganini-Hill A, Ross RK & Henderson B (1984): Assessment of three brief methods of estimation of vitamin A and C intakes for a prospective study of cancer: comparison with dietary history. *Am. J. Epidemiol.* **119**, 581–590.

Groot EH & Hautvast JGA (1979): Zin en onzin van het voorschrijven van multivitaminepreparaten aan bejaarden. *Ned. Tijdschr. Geneeskd.* **123**, 1339–1344.

Harlow SD & Linet MS (1989): Agreement between questionnaire data and medical records. The evidence for accuracy of recall. *Am. J. Epidemiol.* **129**, 233–248.

Kellett M, Kelleher E, Crutchfields J, Dubes M, Glasser C & Lazure G (1984): Vitamin and mineral supplement usage by retired citizens. *J. Nutr. Elderly* **3**, 7–19.

Kune S, Kune GA & Watson LF (1987): Observations on the reliability and validity of the design and diet history method in the Melbourne colorectal cancer study. *Nutr. Cancer* **9**, 5–20.

Landis JR & Koch GG (1977): The measurement of observer agreement for categorical data. *Biometrics* **33**, 159–174.

Levy AS & Schucker RE (1987): Patterns of nutrient intake among dietary supplement users: attitudinal and behavioral correlates. *J. Am. Diet. Assoc.* **87**, 754–760.

Nelson M (1991): The validation of dietary questionnaires. In *Design concepts in nutritional epidemiology*, eds BM Margetts & M Nelson, pp. 266–296. Oxford: Oxford University Press.

Paganini-Hill A & Ross RK (1982): Reliability of recall of drug usage and other health-related information. *Am. J. Epidemiol.* **116**, 114–122.

Park YK, Kim I & Yetley EA (1991): Characteristics of vitamin and mineral supplement products in the United States. *Am. J. Clin. Nutr.* **54**, 750–759.

Payette H & Gray-Donald K (1991): Do vitamin and mineral supplements improve the dietary intake of elderly Canadians? *Can. J. Publ. Hlth* **82**, 58–60.

Pecoraro RE, Inui TS, Chen MS, Plorde DK & Heller JL (1979): Validity and reliability of a self-administered health history questionnaire. *Publ. Hlth Rep.* **94**, 231–238.

Read MH & Graney AS (1982): Food supplement usage by the elderly. *J. Am. Diet. Assoc.* **80**, 250–253.

Schneider CA & Nordlung DJ (1983): Prevalence of vitamin and mineral supplement use in the elderly. *J.*

Fam. Practice **17**, 243–247.

Sobal J, Muncie HL & Koch H (1988): Prescription and recommendation of multivitamins by physicians in office based amulatory care in the United States. *Nutr. Res.* **8**, 1129–1141.

Sorensen AA, Sorensen DI & Zimmer JG (1979): Appropriateness of vitamin and mineral prescription orders for residents of health related facilities. *J. Am. Geriatr. Soc.* **27**, 425–430.

Subar AF & Block G (1990): Use of vitamin and mineral supplements: demographics and amounts of nutrients consumed. *Am. J. Epidemiol.* **132**, 1091–1101.

Thompson MP & Tollison JW (1990): Caring for the elderly. In *Textbook of family practice*, 4th edn, ed. RE Rakel, pp. 169–170. Philadelphia: W.B. Saunders.

Turlings JDM & Feenstra MH (1987): *Aanbod en gebruik van voedingssupplementen.* 's Gravenhage, The Netherlands: SWOKA Institute for Consumer Research.

Van den Brandt PA, Goldbohm RA, Van't Veer P, Volovics A, Hermus RJJ & Sturmans F (1990): A large-scale prospective cohort study on diet and cancer in the Netherlands. *J. Clin. Epidemiol.* **43**, 285–295.

Van den Brandt PA, Petri H, Dorant E, Goldbohm RA & Van de Crommert S (1991): Comparison of questionnaire information and pharmacy data on drug use. *Pharm. Weekbl[Sci].* **13**, 91–96.

Willett W, Sampson L, Bain C, Rosner B, Hennekens CH, Witschie J & Speizer FE (1981): Vitamin supplement use among registered nurses. *Am. J. Clin. Nutr.* **34**, 1121–1125.

Willett W, Sampson L, Stampfer MJ, Rosner B, Bain C, Witschi J, Hennekens CH & Speizer F (1985): Reproducibility and validity of a semiquantitative food frequency questionnaire. *Am. J. Epidemiol.* **122**, 51–65.

Worsley A & Crawford D (1984): Australian dietary supplementation practices. Health and dietary supplements. *Med. J. Aust.* **140**, 579–583.